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MEASUREMENT BASED CONSTRUCTION AND ANALYSIS OF REALISTIC REPRESENTATIVE UNIT CELLS FOR TEXTILE LAMINATES

R.D.B. Sevenois*[1,2], D. Garoz[1,2], F.A. Gilabert[1,2], S.W.F. Spronk[1,2], M. Kersemans[1], W. Van Paepegem[1]

[1]Department of Materials Science and Engineering, Faculty of Engineering and Architecture, Ghent University, Tech Lane Ghent Science Park – Campus A, Technologiepark Zwijnaarde 903, B-9052 Zwijnaarde, Belgium

[2] SIM Program M3Strength, Tech Lane Ghent Science Park – Campus A, Technologiepark Zwijnaarde 935, B-9052 Zwijnaarde, Belgium

* ruben.sevenois@ugent.be

Representative Unit Cells (RUCs) of textile composites are extensively used for the prediction of their pristine mechanical properties. Although the standard models can be safely used for macro-homogenization, they cannot be used for damage analysis because the oversimplification of the geometrical shapes and paths of the yarns results in unrealistically high internal stresses, Figure 1. To improve these models, the Measurement Enhanced Shape Identification (MESI) procedure is proposed [1]. The advanced technique retains the advantage of an analytical formulation from the standard models but introduces variable asymmetric yarn cross sectional shapes and paths which can be tailored to the yarn shapes and cross sectional areas from in-situ measurements. This way, the common problems of interpenetrations between yarns and incorrect fibre volume fractions are avoided, meshing becomes much easier and the internal stresses can be more accurately estimated. The validity of the MESI method is shown in two ways. First by comparing the predicted to the ultrasonically measured [2] 3D stiffness tensor. Second by comparing the internal stresses of the model to the internal stress of an idealized RUC with constant cross section; and a model from direct in-situ micro computed X-ray tomography. If resources permit, the applicability of the approach to different weaving patterns (plain and twill) is also shown.

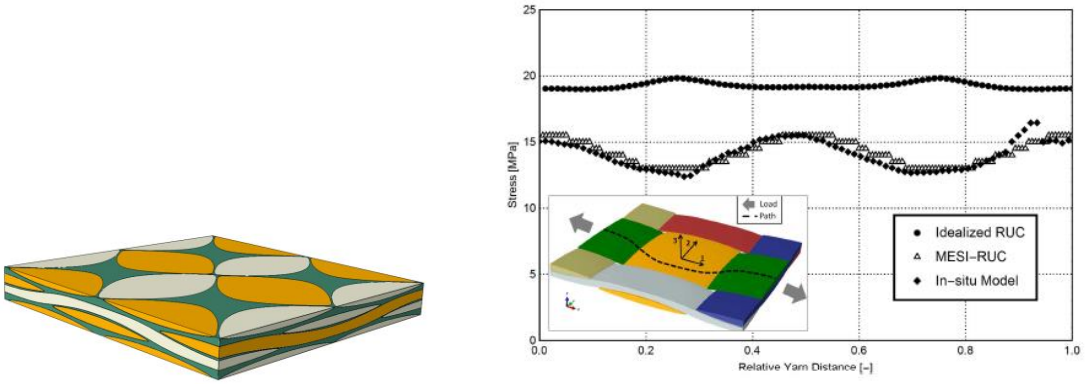

Figure 1. MESI-RUC (left) and comparison of local stress in the yarn from RUC generated with different techniques (right)

References

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